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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/668,702	09/23/2003	Keng-Chu Lin	24061.22	2195

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EXAMINER	
GEBREMARIAM, SAMUEL A	

ART UNIT	PAPER NUMBER
2811	

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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	10/668,702	LIN ET AL.	
	Examiner	Art Unit	
	SAMUEL A. GEBREMARIAM	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *30 August 2009*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,2,4-7,9-16,21,24 and 25* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,4-7,9-16,21,24 and 25* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *5/14/09*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

2. Claims 1, 4, 7 and 9-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al., US 6,472,306 in view of Lee (512) et al., US 6,649,512 and in further view of Yamaguchi JP 59182284.

Regarding claim 1, Lee teaches (figs. 9-16) a method of forming a semiconductor device having a first layer (102) underlying a second layer (132), the method comprising: forming a glue layer (104) directly on the first layer (102), wherein the first layer is metal layer (copper metal lines); and depositing the second layer (132) directly onto the upper surface of the first layer (102) and the second layer is a metal layer (copper).

Lee does not explicitly teach performing an inter-treatment on the glue layer, wherein the inter-treatment affects the upper and lower surfaces of the glue layer and improves an adhesive interface between the glue layer and the first layer and wherein the inter-treatment includes applying a plasma and electron beam and wherein the inter-

treated glue layer improves adhesion between the first and second layers or a reacting gas of the plasma includes at least one of hydrogen based gas and a helium based gas.

Lee (512) teaches performing an inter-treatment on a glue/sealing layer (fig. 2b), wherein the inter-treatment affects the upper and lower surfaces of the glue layer and improves an adhesive interface between the glue layer and the first layer (col. 3, lines 28-40, Lee teaches that the plasma treatment improves adhesion between the low-k film and the sealing layer) and wherein the inter-treatment includes applying a plasma, where the plasma includes at least one of hydrogen based gas (col. 3, lines 5-15).

Yamaguchi teaches (refer to the abstract) electron beam irradiation of silicon nitride layer improves adhesion of silicon nitride layer to metal or metal oxide.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the process of performing an inter-treatment on the glue layer/sealing layer, where the plasma includes at least one of hydrogen based gas as taught by Lee (512) in the process of Lee in order to improve the adhesion between the low-k dielectric layer and the glue/sealing layer. Since the combined process of Lee and Lee (512) teaches the same process as the claimed invention, the modified process teaches that the inter-treatment affects the upper and lower surfaces of the glue layer and this in turn improves an adhesive interface between the first layer and the second layer layer. The modified process also teaches depositing the second layer directly onto the upper surface of the inter-treated glue layer.

Furthermore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the electron beam treatment of the silicon

nitride layer as taught by Yamaguchi in the combined process of Lee in order to further improve the adhesion of silicon nitride layer to the metal.

The limitations of "a method for increasing a time dependent dielectric breakdown lifetime of a semiconductor device" is not given patentable weight because a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). Furthermore since Lee as modified by Yamaguchi teaches the same as the claimed invention, the modified process is inherently capable of increasing a time dependent dielectric breakdown lifetime of the semiconductor device.

Regarding claim 4, Lee teaches substantially the entire claimed process of claim 1 above including selecting a reacting gas, a process time, a process temperature, a process pressure, and a reacting gas flow (refer to col. 3, lines 5-15, Lee (512)).

Regarding claim 5, Lee teaches substantially the entire claimed process of claim 1 above including the reacting gas is a hydrogen-based gas (refer to col. 3, lines 5-15, Lee (512)).

Regarding claim 7, Lee teaches substantially the entire claimed process of claims 1 and 4 above except explicitly stating that the selected process time is between approximately 1 and 100 seconds, the selected process temperature is between

approximately 200 and 400° C, the selected process pressure is between approximately 0.5 and 10 torr. Lee (512) teaches the selected reacting gas flow is between approximately 100 and 2500 sccm (col. 3, lines 5-15).

Parameters such as process time, temperature and pressure are subject to routine experimentation and optimization to achieve the optimum device characteristics during fabrication.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to adjust the process time, the temperature range and pressure as claimed in the process of Lee in order to form a high quality glue layer.

Regarding claim 9, Lee teaches substantially the entire claimed process of claims 1 and 8 above including the inter-treatment including the electron beam further comprises defining a process power and a dosage (electron beam process requires power and electron beam energy, hence requires defining a process power and a dosage).

Regarding claims 10 and 11, Lee teaches substantially the entire claimed process of claims 1 and 8 above except explicitly stating that that the process power is between approximately 1000 eV and 8000 eV and the dosage is between approximately 50 and 500 $\mu C/cm^2$.

Parameters such as process power and dosage are subject to routine experimentation and optimization to achieve the desired device characteristics during fabrication.

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made adjust the process power and dosage as claimed in the process of Lee in order to form a high quality glue layer.

3. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee, Lee (512), and in further view of Yu et al., US 6,764,952.

Regarding claim 2, Lee teaches substantially the entire claimed process of claim 1 above except explicitly stating performing a pre-treatment on the first layer before forming the glue layer.

Yu teaches (fig. 1) a pre-treatment on the first layer before forming the glue layer in order to retard copper diffusion and improve adhesion of copper diffusion layer on the copper surface (abstract).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the pre-treatment on the first layer before forming the glue layer as taught by Yu in the combined process of Lee and Lee (512) in order to retard copper diffusion and improve adhesion of copper diffusion layer on the copper surface.

4. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al., in view of Lee (512) and in further view of Huang US 6,821,571.

Lee teaches substantially the entire claimed process of claim 1 above except explicitly stating the reacting gas is a hydrogen based gas.

Huang teaches (col. 1, lines 66-67 and col. 2, lines 1-19) plasma treatment using helium-based gas to provide surface with improved adhesion and oxidation resistance layers.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the helium-based gas for plasma treatment as taught by Huang in the process of the modified process of Lee in order to provide surface with improved adhesion and oxidation resistance layers.

5. Claims 12-16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al., US 6,472,306 in view of Lee (512) et al., US 6,649,512 and in further view of Huang, US 6,821,571.

Regarding claims 12, Lee teaches depositing a dielectric layer (refer to col. 4, lines 9-16); depositing a first metal layer (102) on the dielectric layer; depositing a glue layer (104) on the dielectric layer (fig. 9) and the first metal layer (102) such that an interface is formed directly between the first metal layer (102) and a lower surface of the glue layer (104) and an interface is formed directly between the dielectric layer (fig. 9) and a lower surface of the glue layer (104); forming a second metal layer (132) directly on the upper surface of the glue layer (104, refer to fig. 16).

Lee does not explicitly teach performing a plasma treatment to affect the upper and lower surfaces of the glue layer; wherein the plasma treatment includes a helium based reactive gas, wherein the affect to the upper and lower surfaces of the glue layer including improving adhesion; wherein the treatment process enhances adhesiveness between the dielectric layer and the second metal layer.

Lee (512) teaches performing an inter-treatment on a glue/sealing layer (fig. 2b), wherein the inter-treatment affects the upper and lower surfaces of the glue layer and improves an adhesive interface between the glue layer and the first layer (col. 3, lines 28-40, Lee (512) teaches that the plasma treatment improves adhesion between the low-k film and the sealing layer) and wherein the inter-treatment includes applying a plasma (col. 3, lines 5-15).

Lee (512) does not explicitly teach that the plasma includes a helium-based reactive gas.

Huang teaches (col. 1, lines 66-67 and col. 2, lines 1-19) plasma treatment using helium-based gas to provide surface with improved adhesion and oxidation resistance layers.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the process of performing an inter-treatment on the glue layer/sealing layer as taught by Lee (512) in the process of Lee in order to improve the adhesion between the low-k dielectric layer and the glue/sealing layer. Since the combined process of Lee and Lee (512) teaches the same as the claimed process, the modified process teaches that the inter-treatment affects the upper and lower surfaces

of the glue layer and this in turn improves an adhesive interface between the first layer and the second layer. The modified process also teaches forming the second metal layer directly onto the upper surface of the glue layer.

Furthermore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the helium-based gas for plasma treatment as taught by Huang in the process of the modified process of Lee in order to provide surface with improved adhesion and oxidation resistance layers.

Since the combined process of Lee, Lee (512) and Huang is the same as the claimed process, Lee as modified by Lee (512) and Huang teaches the treatment process enhances adhesiveness between the dielectric layer and the second metal layer.

The limitations of "a method for increasing a time dependent dielectric breakdown lifetime of a semiconductor device" is not given patentable weight because a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). Furthermore since Lee as modified by Tu teaches the same claimed process, the modified process is inherently capable of increasing a time dependent dielectric breakdown lifetime of the semiconductor device.

Regarding claim 13, Lee teaches the entire claimed process of claim 1 above including the glue layer (104) with a certain thickness.

The limitation "the selected thickness is based at least partially on a desired electrical property of the glue layer" is not given patentable weight because the feature does not add anything to the process of forming the glue layer. Furthermore since Lee is concerned with forming interconnection structure therefore Lee's process is inherently concerned with finding the desired electrical property of the glue layer.

Regarding claim 14, Lee as modified by Lee (512) and Huang teaches substantially the entire claimed process of claim 1 above including adjusting a property of the plasma process based on the selected thickness of the glue layer.

Lee teaches forming the treatment over a certain depth of the glue layer. Lee as modified by Lee (512) and Huang is inherently capable of adjusting a property of the selected treatment process based on the selected thickness of the glue layer.

Regarding claim15, Lee teaches substantially the entire claimed process of claims 1 and 14 including the duration of the plasma process (col., 4, lines 19-27, Huang).

Regarding claim 16, Lee teaches the entire claimed process of claim 12 above including the glue layer is SiN (104).

6. Claims 21 and 24 are rejected under 35 U.S.C. 103(a) as being unpatentable over Lee in view of Lee (512).

Regarding claim 21, Lee teaches (figs. 9-16) forming a dielectric layer (refer to col. 4, lines 9-16); forming a first metal layer (102) adjacent the dielectric layer (fig. 9); forming a glue/sealing layer (104) on the first metal layer (104) such that a first interface is formed directly between metal of the first metal layer (102) and a lower surface of the glue layer (104) and a second interface is formed directly between the dielectric layer (100) and a lower surface of the glue layer (104); and forming a second metal layer (132) on the upper surface of the glue layer (104) such that a third interface is formed directly between metal of the second metal layer (132) and the upper surface of the glue layer (104), and wherein the third interface overlies the first interface and second interface (fig. 16).

Lee does not explicitly teach performing an inter-treatment on the glue layer to alter upper and lower surfaces of the glue layer for improved adhesiveness, wherein the performing the inter-treatment includes using a plasma and wherein the plasma includes at least one of a helium-based gas and a hydrogen-based reacting gas.

Lee (512) teaches a plasma treatment process (fig. 2b) and applying the selected treatment process to alter the upper and lower surfaces of the silicon nitride layer (206a, col. 3, lines 5-40), where the plasma includes a hydrogen-based reacting gas col. 3, lines 5-15).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the plasma treatment process taught by Lee (512) in the process of Lee in order to improve the adhesion between the low-k dielectric layer and the glue/sealing layer.

Since the combined process of Lee and Lee (512) is the same as the claimed process, Lee as modified by Lee (512) teaches the treatment process enhances adhesiveness between the dielectric layer and the second metal layer.

The limitations of "a method for improving an interface in a semiconductor device" is not given patentable weight because a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963). Furthermore since Lee as modified by Lee (512) teaches the same process as the claimed invention, the modified process is inherently capable of improving an interface in a semiconductor device.

Regarding claim 24, Lee substantially teaches the entire claimed process of claim 21 above including the glue layer SiN (104).

7. Claim 25 is rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al., in view of Lee (512) and in further view of Huang.

Regarding claim 25, Lee teaches (figs. 9-16) forming a first metal layer (102); forming a glue layer (104) directly on the first metal layer (102), wherein the glue layer is

an etch stop layer and includes silicon (layer 104 is formed of silicon nitride); and forming a second metal layer (132) directly on the upper surface of the glue layer (104).

Lee does not explicitly teach performing an inter-treatment on the glue layer to alter upper and lower surfaces of the glue layer for improved adhesiveness wherein the inter-treatment includes using helium-based reacting gas plasma.

Lee (512) teaches a plasma treatment process (fig. 2b) and applying the selected treatment process to affect the upper and lower surfaces of the silicon nitride layer (206a, col. 3, lines 5-40).

Lee (512) does not explicitly teach that the plasma includes a helium-based reactive gas.

Huang teaches (col. 1, lines 66-67 and col. 2, lines 1-19) plasma treatment using helium-based gas to provide surface with improved adhesion and oxidation resistance layers.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the plasma treatment process taught by Lee (512) in the process of Lee in order to improve the adhesion between the low-k dielectric layer and the glue/sealing layer.

Furthermore it would have been obvious to one of ordinary skill in the art at the time the invention was made to incorporate the helium-based gas for plasma treatment as taught by Huang in the process of the modified process of Lee in order to provide surface with improved adhesion and oxidation resistance layers.

Since the combined process of Lee, Lee (512) and Huang is the same as the claimed process, Lee as modified by Lee (512) and Huang teaches the treatment process enhances adhesiveness between the dielectric layer and the second metal layer.

Furthermore the combined process of Lee and Lee (512) and Huang teaches the inter-treatment on the glue layer alters the upper and lower surface of the glue layer; the second metal layer is formed directly on the altered upper surface of the glue layer and improves adhesiveness.

The limitations of "a method for improving an interface in a semiconductor device" is not given patentable weight because a recitation of the intended use of the claimed invention must result in a structural difference between the claimed invention and the prior art in order to patentably distinguish the claimed invention from the prior art. If the prior art structure is capable of performing the intended use, then it meets the claim. In a claim drawn to a process of making, the intended use must result in a manipulative difference as compared to the prior art. See *In re Casey*, 152 USPQ 235 (CCPA 1967) and *In re Otto*, 136 USPQ 458, 459 (CCPA 1963).

Response to Arguments

8. Applicant's arguments with respect to claims 1-2, 4-7, 9-16, 21 and 24-25 have been considered but are moot in view of the new ground(s) of rejection. With respect to applicant's argument that examiner has not shown that the inter-treatment improves an adhesive interface between the glue layer and the first layer, it clearly shown that

applying a plasma treatment on the sealing/glue layer (206a) is intended to prevent peeling of the sealing/glue from during subsequent processing. Since Lee teaches the same type of low-k materials from below and above the glue layer and Lee teaches that the plasma treatment affect the both the upper and lower surfaces of the glue layer. Furthermore the sealing/glue is thin enough that the plasma penetrates the lower surfaces of the sealing/glue layer.

Conclusion

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to LYNNE A. GURLEY whose telephone number is (571)272-1670. The examiner can normally be reached on M-F 7:30-4:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynne A. Gurley can be reached on 571-272-1670. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Samuel A Gebremariam/

Examiner, Art Unit 2811

/SAG/

December 6, 2009